Phytoplankton Diversity in Lakes of the McMurdo Dry Valleys, Antarctica

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Introduction

Long-term research in the McMurdo Dry Valley Lakes, Antarctica has led to questions concerning the relationship between biodiversity and ecosystem function. A major theme of the latest MCM LTER proposal (2005-2011) is to understand how the environment controls the diversity of organisms, and how diversity itself controls the functioning of the MCM ecosystem. Lakes in this ecosystem are likely hundreds of thousands of years old and lie at the end of the hydrologic continuum, representing a repository of past conditions within the MCM. As the key phototrophic organisms in the MCM ecosystem, phytoplankton have an essential role as primary producers of new carbon (Fig. 1). We present phytoplankton diversity data collected from live lake basins within the MCM study area (Fig. 2).

Study Site

The dry valley lakes contain highly stable water columns resulting from perennial ice covers, low advective stream inflow, and strong vertical chemical gradients. Each lake contains unique physical and chemical gradients (Table 1, Fig. 3) which create distinct environments for phytoplankton populations. Temperature, salinity and nutrient conditions vary widely within each lake, and low light conditions (1-3% of surface PAR) persist throughout the 6 month growing season.

Methods

Phytoplankton diversity profiles were obtained during the 2004 and 2005 austral spring and summer using a submersible spectrophotometer, which differentiates the four major groups of phytoplankton in the lakes (cyanobacteria, Chlorophyta, Cryptophyta, Chrysophyta) based on the chlorophyll-a fluorescence excitation spectra of the light harvesting apparatus (Fig. 4). All samples were collected from the deepest portion of each lake.

Results

Results I

In situ spectrophotometer and extracted chl-a: A Comparison

Fig. 4. Principle of underwater spectrophotometry. Algal Chlorophyll-a is excited with light of the LED's emission wavelength 450 nm, 525 nm, 570 nm, 665 nm. An iterative gaussian fit weighted with the standard deviations of the normal spectra facilitates the estimation of the distribution of the spectral groups. Dissolved yellow substances measured at 370 nm are used to correct for background fluorescence in the algal algorithms. Algal group concentrations are given in ug chl-a/L water sample.

Results II

In situ spectrophotometer algal group profiles

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Results III

Phytoplankton diversity in the MCM lakes – Cluster Analysis

Results IV

Phytoplankton diversity in the MCM lakes - Shannon-Weiner Diversity Index

Fig 9. Phytoplankton diversity based on in vivo pigment spectrophotometry. Cluster analysis performed using the ratio of chl-a for each algal group to total chl-a for a depth representing the specific chlorophyll maxima within each lake. Labels denote the data of ‘FRX’, ‘HOR’, ‘ELB’, ‘WLB’, ‘VAN’ and depth included in the analysis.

Conclusions

• Phytoplankton diversity within the lakes of the McMurdo Dry Valleys reflects both contemporary and environmental legacies of past events. Phytoplankton in surface waters receive new nutrients from intermittent glacial stream inflow, release from the ice cover, and internal recycling, and are exposed to relatively high irradiances, whereas those in the deep lakes receive upward diffusing nutrients from ancient nutrient pools that formed as the lakes evolved, and are extremely light limited. These conditions would likely lead to isolated deep water phytoplankton communities that differ between lakes or with surface populations, and live on legacy nutrients (Priscu, 1985). Similarities observed within the surface waters of each lake suggest that these populations are responding to contemporaneous conditions, or that there are interchange of surface and deep water populations between lakes.

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